Physics

By

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Class:10+2

Unit:X

Topic: Communication Systems

Unit X: Communication Systems **10 Periods**

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital data); bandwidth of transmission medium. Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, satellite communication. Need for modulation, amplitude modulation and frequency modulation, advantages of frequency modulation over amplitude modulation. Basic ideas about internet, mobile telephony and global positioning system (GPS).

Q. No	Topic/Question	Page No
1.	Match the following	10/3
2.	a) Draw block Diagram (Scheme) of a generalized communication system and explain each of its component. b) Explain "Point to Point" and "Broadcast Communication".	10/4
3.	Define/Explain the following:- a) Transducer b) Signal c) Noise d) Transmitter e) Receiver f) Attenuation g) Amplification h) Range i) Bandwidth J) Modulation k) Demodulation l) Repeater	10/5
4.	Find Range of a T.V. tower of height h (say 500m)?	10/7
5.	Write Band width for various signals.	10/7
6.	What is the need for modulation?	10/8
7.	Explain propagation of Electromagnetic Waves i.e. a) Ground Wave Propagation. b) Sky Wave Propagation. c) Space Wave Propagation.	10/9
8.	Explain the following with respect to AM a) Amplitude Modulation. b) Modulation index. c) Side bands significance. d) Power distribution in carrier and side bands.	10/10
9.	Production of AM waves.	10/11
10.	Draw the block diagram of a detector for AM signal.	10/12
11.	Write frequency range of Radio waves.	10/13
12.	Explain Internet, Mobile telephony and GPS.	10/13

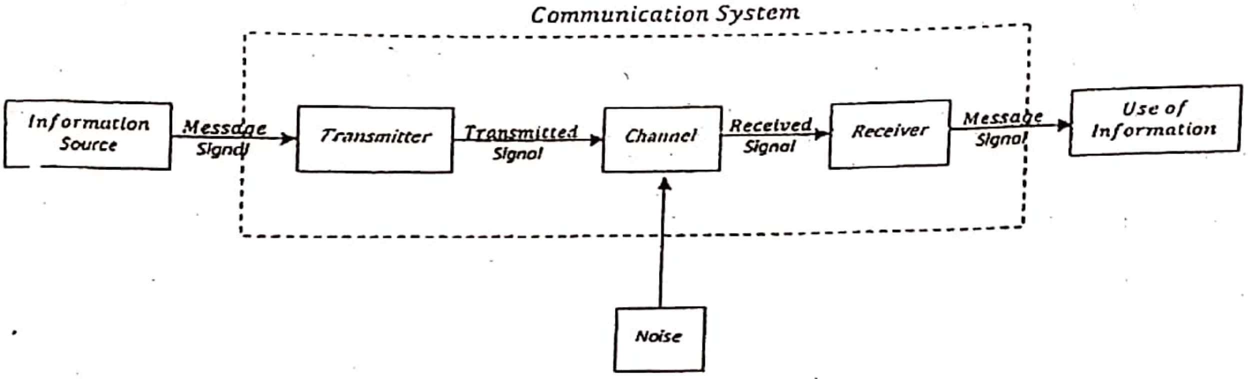
Q1. Match the following:

Ans.

I	II
1. Telegraph	Morse and Wheatstone
2. Telephone	Graham Bell
3. Wireless communication	Jagdish Chandra Bose and Marconi
4. Television	Johan Logi Baird
5. Internet	J.C.P. Licklider
6. W.W.W (World wide web)	Tim Berners Lee

Q2. a) Draw Block diagram (Scheme) of a generalized communication system and explain each of its component?
b) Explain " Point to Point" and "Broadcast Communication".

Ans: a)



i) **Information Source**:-
Information source is a source of data/ signal to be transmitted across communication channel. It may be analogous or digital in form of audio cassette, VCD, soft copy of a file.

ii) **Transmitter**:-
Transmitter converts the message signal into a form suitable for transmitting it through wire/ wireless network.

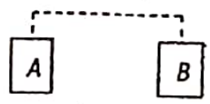
iii) **Channel**:-
Channel is the media between the transmitter and receiver. It may be wireless or with wires.

iv) **Receiver**:-
A receiver extracts the desired message signals from the received signals at the channel output.

v) **Noise**:-
Noise is unwanted signal.

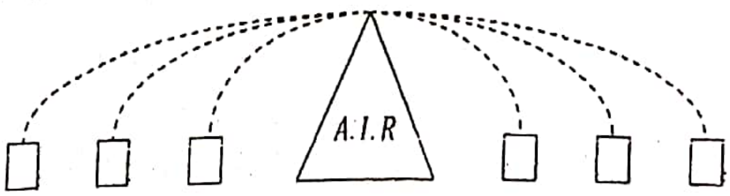
b) Explain "Point to Point" and Broadcast Communication.
In Point to point communication, communication takes place over a link between a single transmitter and receiver.

Example: Telephony



Broadcast Communication
There is large number of receivers corresponding to a single transmitter.

Example: Radio and Television



+2 / Unit 10 / Q2 Block Diagram of communication system

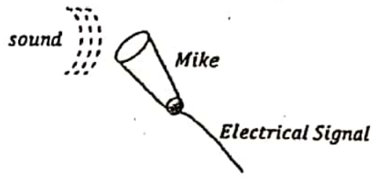
Q3. Define/Explain the following:-

a) Transducer
b) Signal
c) Noise
d) Transmitter
e) Receiver
f) Attenuation
g) Amplification
h) Range
i) Bandwidth
j) Modulation
k) Demodulation
l) Repeater

Ans.

a) Transducer:-

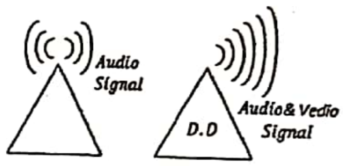
Transducer is a device that converts one form of energy into another.



Example: Mike converts sound energy to electrical signal.

b) Signal:-

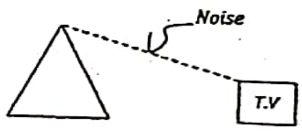
Information converted in electrical form and suitable for transmission.



Example: Signal can be analog or digital.

c) Noise:-

Noise is unwanted signal that disturbs the transmission and processing of message signal in a communication system.



Example: Lightening stroke causes disturbance on Television set. Lightening signal is a source of noise.

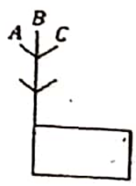
d) Transmitter:-

Transmitter processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.

Example: FM Radio transmitter transmits the signal so that it can travel up to FM radio and easily demodulated by FM radio receiver.

e) Receiver:-

A receiver extracts the desired message signal from the received signals at the channel output.



Example:-

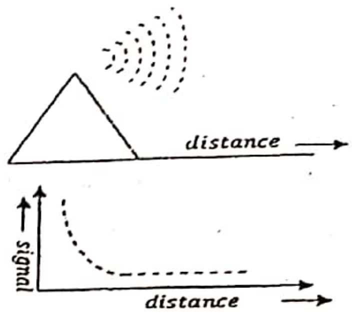
A radio Antenna receives signals from three stations say A,B and C.

+2 / Unit 10 / Q3A Transducer Signal Noise Transmitter

+2 / Unit 10 / Q3B Receiver Attenuation Amplification Demodulation

f) Attenuation:-

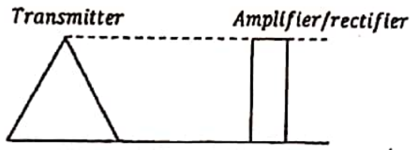
The loss of strength of a signal while propagating through a medium is known as attenuation.

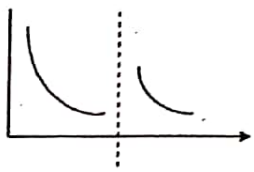


Example: As we move away from tower signal strength decreases.

g) **Amplification:-**

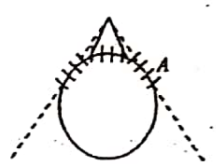
It is the process of increasing the amplitude of a signal using an electronic circuit called the Amplifier.





h) **Range:-**

It is the largest distance between the source and destination up to which the signal received with sufficient strength.

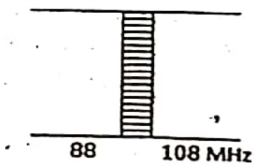


Example: Range of a TV tower is say 200 km.

i) Bandwidth:-

Band width refers to frequency range over which an equipment operates or the portion of the spectrum occupied by the signal

FM radio 88 MHz – 108 MHz



j) Modulation:-

Modulation is process of superimposing message signal on carrier wave

Example: Amplitude modulation (AM)
Frequency Modulation (FM)

k) Demodulation:-

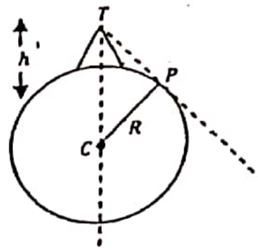
It is the reverse of modulation process of retrieval of information from the carrier wave at the receiver.

Example:- AM receiver separates message from carrier wave through this process of demodulation.

l) Repeater:-

A Repeater picks up the signal from the transmitter amplifies and retransmits it.

Q4. Find Range of a T.V. tower of height h (say 500m)?



Ans. Find range TP = ?

In Δ CPT

$(CT)^2 = (CP)^2 + (PT)^2$

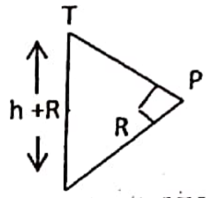
$(R+h)^2 = R^2 + (TP)^2$

$(TP)^2 = (R+h)^2 - R^2$

$= R^2 + h^2 + 2Rh - R^2$

$= h^2 + 2Rh$

$\boxed{TP \simeq \sqrt{2Rh}}$ (As h << R)



Range ∝ $\sqrt{height}$

+2 / Unit 10 / Q4 Range of TV tower

Q5. Write Band width for various signals?

Ans. Speech signal 300 Hz < < 3100 Hz

(Bandwidth = 2800 Hz)

Audio Signal 20 Hz < < 20 KHz

(Bandwidth ≃ 20 KHz)

Service	Frequency bands	Comments
Standard AM broadcast	540-1600 kHz	
FM broadcast	88-108 MHz	
Television	54 – 72 MHz 76 – 88 MHz 174 – 216 MHz 420 -890 MHz	VHF (Very high frequencies) TV UHF (Ultra high frequencies) TV
Cellular Mobile Radio	896-901 MHz 840-935 MHz	Mobile to base station *Base station to mobile*] 850-950 MHz
Satellite Communication	5.925 -6.425 GHz 3.7-4.2 GHz	Uplink Downlink [3 to $7\ GHz$ 3×10^9 to $7 \times 10^9 Hz$.]

+2 / Unit 10 / Q5 Bandwidth

Q6. What is the need for modulation?

Ans: A message signal usually spreads over a range of frequencies called the signal band width.

Suppose we want to transmit electrical signal in the audio frequency (AF) range (20Hz to 20 KHz) over a long distance.

(i) <u>Size of antenna</u>:- An antenna is needed for both the transmission and reception. Each antenna should have a size comparable to the wavelength

of signal i.e $\frac{\lambda}{4}$ in size.

For f = 15 kHz, $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{15 \times 10^3} = 20000$ m

Length of antenna $= \frac{\lambda}{4} = \frac{20000}{4} = 5000$ m.

To set up antenna of vertical height 5000m is impossible.

But if f = 1MHz, $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{10^6} = 300$ m

Length of antenna $= \frac{300}{4} = 75$ m, which is possible.

(ii) <u>Effective power radiated by antenna</u>:- $P \propto \left(\frac{1}{\lambda}\right)^2$, As high powers are needed for good transmission, therefore, for given antenna length l, wavelength should be small and frequency should be high.

(iii) <u>Mixing up of signals from different transmitter</u>:-
When many transmitters are transmitting baseband information signals simultaneously, they get mixed up and there is no difference between them. To avoid mixing, modulation is necessary.

+2 / Unit 10 / Q6 Need for Modulation

+2 / Unit 10 / Q7 Propagation of waves

Q7. Explain propagation of Electromagnetic waves i.e.
(a) Ground Wave Propagation
(b) Sky Wave Propagation
(c) Space Wave Propagation.

Ans: (a) The radio waves which travel through atmosphere following the surface of earth are known as ground waves or surface waves and their propagation is called ground wave propagation or surface wave propagation.

Their intensity falls with distance following inverse square law. That is why these cannot go to very long distance on ground. These type of propagation is suitable for low and medium frequency i.e up to 2 MHz only.

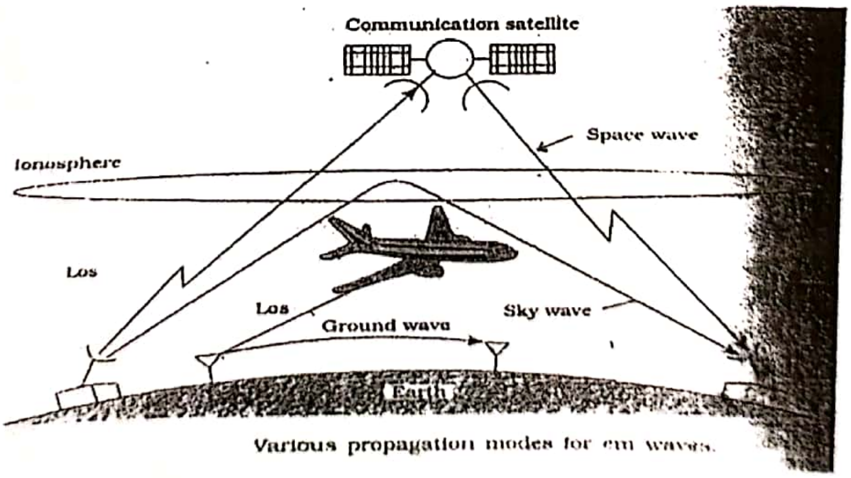
(b) The sky wave propagation is also known as ionosphere propagation, since the sky wave reach the receiver after reflection from ionosphere.

(i) **Critical frequency** (v_c):- It is that highest frequency of radiowave which when sent straight towards the layer of ionosphere gets reflected from ionosphere and returns to the earth.

(ii) **Max usable frequency** (MUF):- It is that highest frequency of radio waves which when sent at some angle towards ionosphere, gets reflected from that and returns to the earth.

(iii) **Skip distance**:- It is the smallest distance from a transmitter along the earth's surface at which sky- wave of a fixed frequency is sent back to earth.

(iv) **Fading**:- It is the variation in the strength of a signal at a receiver due to interference of waves. Fading is more at high frequencies.



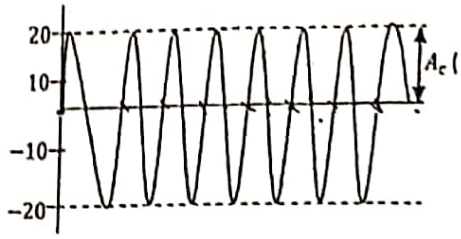
Various propagation modes for em waves.

(c) **Space wave propagation**:-The space wave can travel through atmosphere from transmitter antenna to receiver antenna directly in the earth's troposphere region. The space wave propagation is utilized in very high frequency (V.H.F) bands (between 30 MHz to 300 MHz). Ultra high frequency (U.H.F) bands and microwaves.

+2 / Unit 10 / Q8 Amplitude Modulation Index

Q8. Explain the following with respect to AM
a) Amplitude Modulation.
b) Modulation index.
c) Side bands significance.
d) Power distribution in carrier and side bands.

Ans. a) Amplitude modulation is a modulation in which amplitude of carrier wave varies in accordance with message signal.

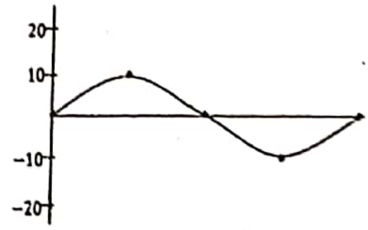


$y = A \sin wt$
↓
Amplitude varies in accordance with message

$$C_m(t) = [A_c + A_m \sin(w_m t)] \sin w_c t$$

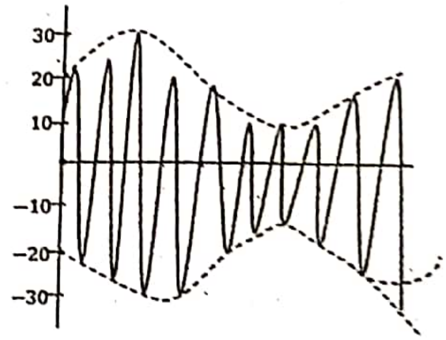
$$= A_c \sin w_c t + A_m \sin(w_m t) \sin(w_c t)$$

$$= A_c \sin w_c t + \frac{A_m . A_c}{A_c} \sin(w_m t) \sin(w_c t)$$



$$C_m(t) = A_c \sin W_c t + \mu A_c \sin(w_m) t \sin(w_c t)$$

$$\boxed{C_m(t) = A_c \sin w_c t + \mu A_c \sin(w_m t) \sin(w_c t)}$$



b) **Modulation Index** μ

$$\mu = \frac{A_m}{A_c} \quad \mu \leqslant 1$$

c) **Side Bands:**

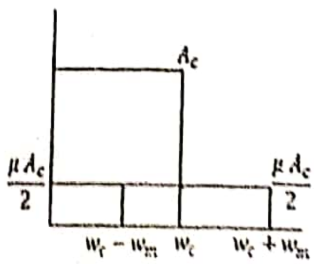
$$C_m(t) = A_c \sin w_c t + \frac{\mu A_c}{2} [2 \underbrace{\sin(w_m t)}_{B} \underbrace{\sin(w_c t)}_{A}$$

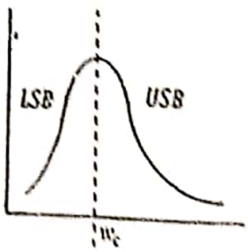
[2 sin A sin B = cos (A – B) – cos (A +B)]

$$C_m(t) = A_c \sin w_c t + \frac{\mu A_c}{2} \{\cos(w_c t - w_m t) - \cos(w_c t + w_m t)\}$$

$$= A_c \sin \underbrace{w_c t}_{w_c} + \frac{\mu A_c}{2} \left\{\cos[(\underbrace{w_c - w_m}_{w_c - w_m})t] - \frac{\mu A_c}{2} \cos[(\underbrace{w_c + w_m}_{w_c + w_m})t]\right\}$$

Components of wave with frequency $(w_c - w_m)$ and $(w_c + w_m)$ are termed as side bands.





(d) **Power:**

$$P_{total} = P_C + P_{L.S.B} + P_{U.S.B}$$

$$= (A_c)^2 + \left(\mu \frac{A_c}{2}\right)^2 + \left(\mu \frac{A_c}{2}\right)^2$$

$$= P_C + \left(\frac{\mu^2}{4}\right) P_c + \left(\frac{\mu^2}{4}\right) P_c$$

Q9. Production of AM waves?

Ans. Step 1.

$$x(t) = c(t) + m(t)$$

$$= A_c \sin(w_c t) + A_m \sin(w_m t)$$

Step 2.

$$y(t) = [x(t)]^2$$

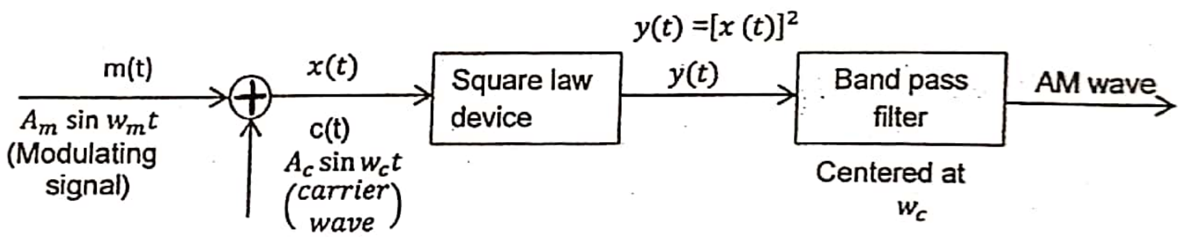
$$= A_c^2 \, sin^2 (w_c t) + A_m^2 \, sin^2 (w_m t) + 2A_c A_m \sin w_c t . (\sin w_m t)$$

$$y(t) = \frac{A_c^2}{2}[(1 - \cos 2 (w_c t)] + \frac{A_m^2}{2} [1 - cos2 (w_m t)]$$

$$+ A_c A_m [\cos (w_c t - w_m t) - \cos(w_c t + w_m t)]$$

$$= \frac{A_c^2}{2} - \frac{A_c^2}{2} \cos 2(w_c t) + \frac{A_m^2}{2} - \frac{A_m^2}{2} \cos 2 (w_m t)$$

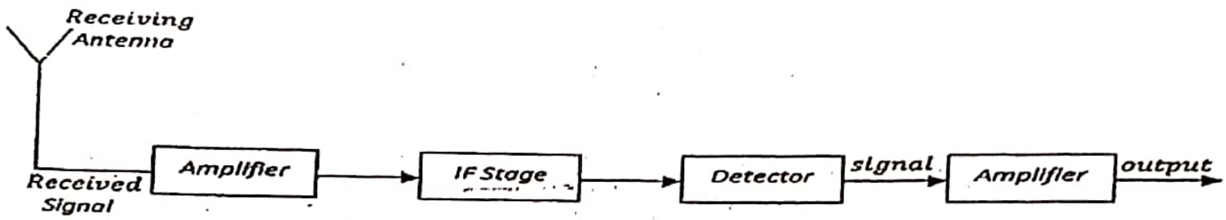
$$+ A_c A_m \text{Cos} [w_c t - w_m t] - A_c A_m \cos [w_c t + w_m t]$$



+2 / Unit 10 / Q9 Production of AM waves

Q10. Draw the block diagram of a detector for AM signal.

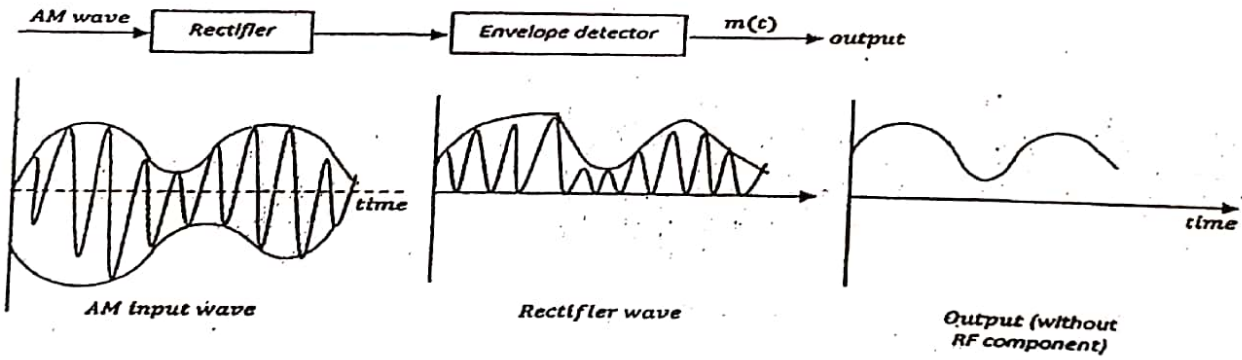
Ans.



IF – Intermediate frequency

Detection is the process of recovering the modulating signal from the modulated carrier wave.

To obtain the original message signal m(t) of angular frequency w_m.



The modulated signal is passed through the rectifier to produce the output. The envelope of signal is the message signal. In order to retrieve $m(t)$, the signal is passed through an envelope detector.

+2 / Unit 10 / Q10 Detection of AM Signal

Q11. Write frequency range of Radiowaves.

Ans. The electromagnetic waves of frequency ranging from a few kilo hertz to a few hundred mega hertz (i.e wavelength 0.3 m or above) are called radio waves.

(1) Medium frequency band (M.F)	0.3 MHz to 3MHz.
(2) High frequency band (H.F)	3 to 30 MHz.
(3) Very high frequency band (V.H.F)	30 to 300 MHz.
(4) Ultra high frequency band (U.H.F)	300 to 3000 MHz.
(5) Super high frequency band (S.H.F)	3000 to 30,000 MHz.
(6) Extra high frequency band (E.H.F)	30 GHz to 300 GHz.

Q12. Explain Internet, mobile telephony and GPS.

Ans. For ans visit.

www.physicslalit.com/communication.pdf

(All small alphabets)